THEORY OF MIND AND INTELLIGENCE RELATIONSHIP BETWEEN AMONG CHILDREN

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DECLARATION

I hereby declare that this dissertation titled **"Relationship between Theory of Mind and Intelligence among children"** is a bonafide work done by me under the guidance of **Dr. Paul S.S. Russell**, Professor of psychiatry, Christian Medical College, Vellore. This work has not been submitted to any university in part or full.

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DECLARATION

I hereby declare that the investigations, which form the subject matter of this thesis, **"Relationship between Theory of Mind and Intelligence among children",** were carried out by **Dr. R. Anto Praveen Rajkumar**, a bonafide trainee in psychiatry, under my guidance. This has not been submitted to any university in part or in full.

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CONTENTS

1. INTRODUCTION

Theory of Mind (ToM) is the cognitive ability to impute mental states to the self and to others (Premack & Woodruff, 1978), to predict and to explain behaviours in terms of mental states. It underlies the ability to comprehend and predict the behaviour of other people and to interpret the actions of others as meaningful and intentional (Rowe & Morris, 2001). It allows one to attribute mental states to others, to understand that other people may hold and act upon beliefs different from one's own. Theory of mind includes the nature and development of our understanding of the inner mental world inhabited by beliefs, desires, attitudes, emotions, thoughts, perceptions, intentions, and other mental states. This appreciation of alternate perspectives is crucial for successful social interaction, communication, adaptation and functioning.

Research on theory of mind has proven to be of interest, not only to psychiatrists but also to researchers and practitioners in fields such as philosophy, developmental psychology, neuro psychology, social psychology, clinical psychology, cultural psychology, cognitive psychology, and education. Many authors have documented Theory of Mind deficits in pervasive developmental disorders, deaf mute children, schizophrenia, acute psychosis, mood disorders and in intellectual disabilities. Theory of Mind deficits has been postulated to be etiologically associated with autism spectrum disorders and with schizotypy, which renders high vulnerability to major psychotic disorders.

There is ongoing debate in cognitive psychology between two conflicting theoretical viewpoints, which consider Theory of Mind as a specific cognitive domain and as a part or product of general cognitive abilities. In spite of selective theory of mind impairment with spared executive function skills in pervasive developmental disorders, specific cortical localization of theory of mind ability with the help of functional neuro

imaging, and neurological lesion studies supporting the presence of Theory of Mind as independent specific cognitive domain, this controversy still lingers due to the existence of conflicting clinical, neuropsychological and research evidence (Fine & Blair, 2001; Zelazo, 2002). Hence, it is indispensable to study the relationship between Theory of Mind and general cognitive abilities such as intelligence, before plunging in to further depths of its deficit related research.

Intelligence is broadly defined as an overall ability for learning and problem solving. There are various standardized test batteries available to quantify Intelligence Quotient (IQ). Children with normal or high IQ may have low theory of mind ability and vice versa. Intelligence is considered to be the prime confounding factor in any assessment of Theory of Mind. However, the direct relationship between IQ and Theory of mind functioning has been less studied systematically (Brune, 2003; Muris, et al, 1998; Yirmiya, et al, 1996; Happe, 1994). Understanding the relationship between theory of mind ability and intelligence quotient is also essential for better planning of care for children with intellectual disabilities. Hence, clarifying the role of IQ is the need of the hour to guide future research and clinical practice.

We therefore perceive that an important area of research in cognitive psychology, involves establishing the relationship between Theory of Mind ability and IQ. Previous studies have investigated the relationship of theory of mind with executive functions and language development, mostly in children with psychopathology (Joseph & Tager-Flusberg, 2004). Hence, a sensible place to begin seems to be to study a population that is not confounded with psychopathology or sensory deficits. A Meta analysis of theory of mind studies in children with intellectual disability asserts that such children have prominent theory of mind deficits which differ depending on various aetiologies of

intellectual disability (Yirmiya, et al., 1998; Cornish, et al, 2005). Studies investigating theory of mind functioning in normal school children who possess average to high range of IQ are sparse. Hence, this inquiry is required to establish the relationship between Theory of Mind and IQ, in children over broad IQ ranges, who are devoid of any psychiatric morbidity.

2. REVIEW OF LITERATURE

2.1. HISTORY OF ToM

The view of the human mind as an intentional agent that contains mental states such as beliefs and desires was present even in ancient Vedic texts. Psychological theorists such as Descartes and Freud have postulated the genesis and development of one's own mental world and it's distinction from the mental world of others. However, the conceptualization of this mentalizing ability as a specific skill, distinct from other cognitive functions, and the term "theory of mind", have emerged relatively recently from the fields of philosophy and developmental psychology. The concept of ToM evolved over the last century, in three major phases (Flavell, 2004). First phase started with Piagetian model of cognitive development. A second phase was the extensive work on Meta cognitive development and the explosion of experimental endeavours to examine existing hypotheses marked the third phase.

2.1.1. First phase

As is true of many areas of cognitive development, the history of Theory of Mind mainly begins with Jean Piaget (Flavell, 2000; Flavell & Miller, 1998; Shantz, 1983). Piaget studied the development of perspective taking. A central Piagetian claim was that children begin development by being cognitively egocentric. Piaget and his colleagues used egocentrism and other concepts to interpret their developmental studies of a wide variety of social-cognitive topics: perceptual perspective taking; egocentric communication; the misattribution of mental characteristics to physical objects, that is animism and physical characteristics to mental events that is realism; and understanding of thoughts, dreams, intentions, and morality. Research on some of these topics still continues, although usually not from a Piagetian theoretical perspective (Woolley & Boerger, 2002).

2.1.2. Second phase

A second wave of theory and research in this area was the extensive work on Meta cognitive development that began in the early 1970s. Meta cognition has been defined as any knowledge or cognitive activity that takes as its object, or regulates, any aspect of any cognitive activity (Flavell & Miller, 2002). Many studies have investigated children's Meta memory, that is, their knowledge about variables affecting memory performance and, especially, their knowledge and use of memory strategies. Research in the Meta cognitive development has been performed on cognition concerning comprehension, communication, language, perception, attention, and problem solving.

Prior to 1983, most investigators of children's knowledge about the mind would probably classify their work as either Meta cognitive or in the general Piagetian tradition. The impetus for the term "Theory of Mind" was in 1978, when a seminal paper, "Does the chimpanzee have a 'theory of mind'?" was published (Premack& Woodruff, 1978). They reported the possibility that chimpanzees are implicitly aware that different individuals can have different thoughts and use this ability to predict their behaviour. Wellman and his co-workers had also independently conceptualized children's developing Meta cognitive knowledge and understanding of mental terms as the development of a Theory of Mind (Wellman, 1985). Then on, the term 'Theory of Mind" is in vogue in the developmental and cognitive psychology literature.

2.1.3. Third phase

Third phase was characterised by explosion of research, which modified theoretical concepts in to experimental hypotheses and then into objective evidence. Dennet first proposed a stringent test for the presence of theory of mind, the prediction of another person's behaviour on the basis of that person's false belief (Dennet, 1978). This concept was refined to an experimental paradigm by two Austrian psychologists, Heinz

Wimmer and Josef Ferner in 1983. In a highly influential series of studies, they used the "unexpected transfer" method to test young children's understanding of false belief (Wimmer & Ferner, 1983). This led to an alliance of Meta cognitive researchers with other researchers who were working with related cognitive modalities such as children's knowledge about perception and about the appearance-reality distinction. This alliance became the Theory of Mind movement, which secured further identity and coherence by two conferences that were held in the spring of 1986. The presentations given at these two conferences were later published in a book entitled “Developing Theories of Mind” (Astington & Olson, 1988), and the movement was officially launched.

Much of the earliest work was focused on documenting a salient improvement between three and five years of age in children's performance on various false-belief, appearance-reality, and visual perspective-taking tasks. Then, research has progressed concurrently in a variety of directions and majority of the literature over the last 20 years deals with such experimental ventures to study the development and deficits of mentalizing and central coherence in normally developing children and children with psychopathology and neurological impairment (Stuss & Alexander, 2001).

2.2. THEORIES ABOUT ToM:

Although the core definition of theory of mind holds fairly constant, the structure and processes of this mental state attribution ability have been described from radically different theoretical perspectives. It is important to understand the different theories of theory of mind, because each makes different predictions about the nature of mentalizing ability and supports different claims about the existence of specific neural structures that might sub serve theory of mind. Three major psychological theories are theory theory, modularity theory and simulation theory. They differ on their emphasis

on the roles of experience, neurological maturation and role taking in the development of ToM respectively.

2.2.1. Theory Theory:

The theory theory views theory of mind as a developing, evolving theory about other minds that is revised with experience over time. This theoretical stance posits several different theories of mind that replace one another as an individual's appreciation of alternate, cognitive perspectives becomes increasingly more sophisticated (Gopnik & Wellman, 1994). Theory-theory holds that theory of mind is not an innate ability; however it may be based upon an innate, general theory formation mechanism, or even on an innate, primitive, mind oriented, starting state theory (Gopnik & Meltzoff, 2000). Theory theory does not view theory of mind as a specific cognitive domain, but rather as a specialized, cognitive skill dependent on the operation of more general inferential abilities, and perhaps dependent upon general theory-formation mechanisms as well. It does not support a specific, dedicated neural system for theory of mind. A number of steps in children's progression toward the adult theory of mind have been described. Children begin with a desire psychology, then progress to a desire belief psychology, and finally attain adult belief desire psychology, in which one recognizes that what people believe, as well as what they desire, crucially affects how they behave (Bartsch& Wellman, 1995). Theory theorists argue that experience plays a major formative role in children's theory of-mind development.

2.2.2. Modular theory:

A module is defined as an innate, encapsulated and domain specific part of cognitive architecture (Leslie & Thaiss, 1992). Modules can be classified as synchronic modules, which imply static capacity, and diachronic modules, which developmentally attain

their capacity from the environment, by a process termed as parameterization. Such parameters are essentially variables whose predetermined potential values can be set by experience (Segal, 1996). Theory of Mind is theorized to be a diachronic module which has a specific innate basis but developmentally dynamic by its interaction with environment. Hence, modular theorists claim that Theory of Mind exists as a distinct, cognitive ability that is functionally dissociable from other cognitive functions. In addition, they assert that the Theory of Mind module is innate, follows a pre-set developmental course, and matures relatively independently from other cognitive skills (Leslie & Roth, 1993). Modular theorists also make a clear distinction between inferencing about abstract mental states, which is a theory of mind skill, and inferencing about the physical world, which is considered to be a general inferencing skill, unrelated to theory of mind (Binnie & Williams, 2003). They support the existence of one or more neural structures specifically dedicated to theory of mind. Experience may be necessary to trigger the operation of these neural mechanisms, but it does not determine their nature.

The dissociation between theory of mind and other high- level cognitive skills as evidenced in studies of autism (Baron-Cohen & Frith, 1995) provide strong evidence that theory of mind may indeed be a distinct, domain specific skill, as modular theorists claim. Further support for the domain specificity of theory of mind comes from the cross cultural studies which established a uniform developmental stage sequence for theory of mind in children across cultures (Avis & Harris, 1991; Jin & Chen, 2002), and from geriatric studies which indicate that theory of mind may be selectively preserved, and even enhanced, in the normal elderly population, relative to memory and other cognitive abilities (Happe & Brownell, 1998).

2.2.3. Simulation theory:

Simulation theorists propose that theory of mind ability can be most accurately conceived of as an act of role taking (Langdon & Coltheart, 2001). From this perspective, individuals simulate what reality would look like to another person by mentally placing themselves into that person's perspective, and then predicting what they themselves would do in the other person's place. Simulation theory does not differentiate between abstract, cognitive perspective taking and concrete, visual perspective-taking that involves mental manipulation of a physical environment. This is in contrast with modular theory, which clearly differentiates mental state inferences from inferences about the concrete, physical world. In addition, simulation theory does not require the meta-representational computations about reality that are imposed by some modular theorists (Leslie & Roth, 1993). Little empirical evidence exists for this general perspective taking, simulation theory. This theory does not predict the existence of a specialized, distinct neural architecture for theory of mind ability. Like theory theorists, simulation theorists also assume that experience plays a crucial formative role, in that it is through practice in role taking that children improve their simulation abilities.

2.3. COMPONENTS OF ToM:

Thanks to contemporary broader definitions, Theory of Mind is no longer considered a simple cognitive faculty such as false belief. It exemplifies a complex cognitive architecture with divergent Meta representational applications. Hence, Theory of Mind is proposed to be made of multiple discrete components by various investigators.

2.3.1. Fundamental components

Theory of Mind has explicit mental state language and implicit behavioural components. They involve two major fundamental components. They are ontological component, that is ability to distinguish between real and mental world and causal component that is ability to understand mutual casual relationships between mental states and physical behavioural world (Yirmiya, et al, 1998; Wellman, 1990).

2.3.2. Neuro physiological components

A review of functional neuro imaging studies reveal a system with three neural components consistently activated during both implicit and explicit mentalizing tasks. They are medial prefrontal cortex, temporal poles and posterior superior temporal sulcus. The functions of the medial prefrontal cortex can be elucidated the basis of a decoupling mechanism that distinguishes mental state representations from physical state representations; the posterior superior temporal sulcus region is probably the basis of the detection of agency, and the temporal poles might be involved in preference for social stimuli. The activation of these components in concert appears to be critical to theory of mind functioning (Frith& Frith, 2003). Other related neural components, particularly amygdala and mirror neurons are also found to play some role in the development of the circuitry mediating theory of mind (Fine & Blair, 2001).

Another neuro biological model proposed for Theory of Mind presents two components. It is composed of a representational component sub served by posterior temporal and parietal lobes and an application or execution component sub served by prefrontal regions. Information processed in posterior regions is relayed through a limbic para limbic system, which is essential for the implementation of theory of mind processes (Abu – Akel, 2003).

2.3.3. Social components

There are two distinct social components of a Theory of Mind. They are social-cognitive component and social perceptual component. They are proposed to have distinct neurobiological substrates which are dissociable. They may be selectively impaired or spared in specific conditions such as William's syndrome in which social perceptual component is spared but the social cognitive component is impaired (Tager-Flusberg & Sullivan, 2000).

2.3.4. Developmental components

During the development of children's understanding of mind, diverse components appear in a programmed chronological order. It is proposed that the late-developing components of Theory of Mind rely on a different neural mechanism from the early-developing components, and that these mechanisms remain distinct into adulthood (Saxe & Wexler, 2005). These components include elements dealing with visual perception, attention, desires, beliefs, emotions, knowledge, pretense, thinking and Meta thinking. Hence, the componential view of Theory of Mind slices the understanding of mind in to various levels of development of these elements.

Even during the early preschool period, children realize that a person will see an object if and only if the person's eyes are aimed in the general direction of the object, and if there are no vision-blocking obstacles interposed between the person and the object (Flavell, 1992). They are able to do simple, non-egocentric visual perspective-taking, such as inferring that others may see something that they do not and vice versa. This is termed as *Level 1* knowledge about *visual perception*. In the preschool period, they go on to recognize that the same thing may present different visual appearances to two people if they view it from different positions that is *Level 2* knowledge of visual perception.

Even infants pay *attention* to other people's attending and seem to have some understanding of its implications (Tomasello & Haberl, 2003). In subsequent years, they appreciate that attention is selective and limited and that different people may mentally represent the same attended input differently (Fabricius & Schwanenflugel, 1994). By the age of three, children not only use some *desire* terms correctly, they also seem to grasp simple causal relations among desires, outcomes, emotions, and actions. For example, they understand that people will feel good if they get what they want and feel bad if they do not (Bartsch & Wellman, 1995).

It has been documented that young preschoolers actually attribute inner feelings to people who display *emotions* (Wellman & Sinclair, 1995). Then, children learn more advanced truths about emotions, that people do not always really feel what they appear to feel and that people's emotional reactions to an event may be influenced by earlier emotional experiences with similar events or by their current mood (Flavell & Miller, 1998). Some important elementary knowledge concerning *thinking* such as construing it as an internal human activity that represents real or imaginary things develops during the early preschool years (Wellman& Schult, 1996).

Children's *knowledge* about mental representations continues to increase after the preschool period. It is not until middle childhood that children appear to gain any substantial understanding of the mind as an active, interpretive, constructive processor (Barquero & Thomas, 2003; Carpendale & Chandler, 1996). For instance, understanding that people's interpretation of an ambiguous event may be influenced by their pre-existing biases or expectations seems to be a largely middle-childhood insight (Pillow & Henrichon, 1996). Young preschoolers appear to be unclear about just what it means for someone to know something and about how knowledge is acquired (Flavell & Miller, 1998). Even older preschoolers may claim that they have always

known information that they have just learned during the experimental session (Taylor & Bennett, 1994). An important early middle-childhood discovery is their burgeoning conception of the mind as an interpretive device for knowledge acquisition. Similarly, children develop understanding of *pretense*, Meta thinking and their implications sequentially (Harris, 2000; Flavell & Flavell, 1995).

2.4. ASSESSMENT OF THEORY OF MIND:

Over the past three decades, several tasks or tests for the assessment of Theory of Mind have been developed. Their methodology widely varies depending on their differing theoretical backdrop. Even though most of these tests were not formally validated and there are rousing controversies over their ability to assess Theory of Mind, they did facilitate the accumulation of current knowledge and progress of this field. These assessments can be broadly classified as tests of false belief, abstract language and high order tasks such as emotion recognition and social perception tests.

2.4.1. False belief tests

Classical prototype method is the test of false belief, proposed by Dennett as a method of demonstrating that an individual is able to ascribe mental states to others. False beliefs are used because it is necessary to establish that an individual being tested is able to attribute beliefs to others that are different from his own beliefs. These tests of false beliefs are the most established, and the most theoretically valid method of establishing theory of mind ability or impairment. *First order false belief tests* establish whether an individual can correctly predict the actions of a character based upon attribution to that character of a false belief. For example, an individual might observe a character, Sara, moving a cookie from its hiding place once a second character, Jim, has left the room. The individual completing the false belief task would display intact first

order false belief attribution if he predicted that Jim, upon re entering the room, would look for the cookie in its old location rather than its new hiding place. In order to make this correct prediction, the individual must be able to look beyond, or inhibit, his own knowledge of reality, and rely instead on his understanding of the false belief held by another person. Children can correctly make first order false belief mental state attributions at three to four years of age (Wimmer & Ferner, 1983).

Second order false belief tests are more difficult tasks that establish whether an individual can correctly attribute a false belief about a belief. For example, if unbeknownst to Sara but known to the individual being tested, Jim peeked back into the room and observed Sara changing the hiding place of the cookie; Sara would then falsely believe that Jim believes the cookie is still hidden in its original location. Sara would hold a false belief about Jim's belief. Children generally pass second order false belief tests at age six or seven (Wimmer & Ferner, 1983).

2.4.2. Abstract language tests

More complex and subtle tests of theory of mind have been developed recently that involve the interpretation of abstract or non-literal language such as sarcasm, irony or deceit. Investigators who use these tests of Theory of Mind claim that often, interpretation of non-literal language involves understanding what a speaker knows, believes, or intends (Baron-Cohen & Plaisted, 1997). Other tests used tasks that required understanding irony and metaphor (Happe, 1994b), tasks to distinguish lies from jokes (Winner & Pincus, 1998), test of mental lexicon words and *faux pas* tasks which involve understanding of why the speaker should not have said what he said and that the speaker does not realize that he has spoken in error, and why the listener would feel insulted or hurt (Baron-Cohen & Plaisted, 1997).

2.4.3. High order tests

Further high order tasks include tests of emotion recognition and of social components. In *Reading the Mind in the Eyes task*, subjects view a series of eye region photographs, and select from given choices the emotion expressed in the eyes. There are also other emotion recognition and emotion behaviour tasks such as empathic accuracy task (Buitelaar & van der Gaag, 1999.). Tests for social perception and social cognition are also available (Samson & Humphreys, 2005). Although such high- level tasks require attribution of mental states, the validity of these tasks as specific measures of theory of mind ability has yet to be established. Such tasks are confounded by a coincident increase in level of cognitive difficulty and demands on working memory. They require the participant to understand non- literal language, to infer implicit meanings, and to recognize and understand complex social situations. Even though investigators generally attempt to control for confounding cognitive variables such as these, high-level Theory of Mind tasks require a level of complex cognitive skill that is very difficult to control for. Performance on these tasks and other, non traditional theory of mind tasks should be interpreted cautiously, as they may require alternative cognitive skills in addition to or instead of the attribution of mental states to others. These difficulties are partially overcome by adding questions of comprehension, assessing general inferencing ability and providing written or pictorial recall materials during testing.

2.5. THEORY OF MIND IMPAIRMENT

Impairment of Theory of Mind may be selective as in pervasive developmental disorders or may be indiscriminate as in Alzheimer's Dementia. Such impairment may be state related as in acute psychosis or may be trait related as in intellectual disability. It may be congenital as in chromosomal abnormalities or may be acquired following

cerebral vascular accidents. It can also be predisposing as in schizotypy or be residual as in remitted mood disorders, in relation to other psychiatric disorders.

2.5.1. ToM & pervasive developmental disorders

Selective Theory of Mind impairment is a core cognitive feature of autism and its spectrum conditions (Baron-Cohen, 2001). Autistic children have weak central coherence, which is the impaired ability to integrate information in context with intact or superior ability to perceive local details (Frith, 1989). Children with autism usually have impaired mental physical distinction, appearance reality distinction, spontaneous pretend play, imagination and poor performance during false belief, mental lexicon tasks and tests of deception and pragmatics. They may fail to reflect one's own imagination (Leslie, 1987) or to switch attention flexibly from 'reality mode' to 'pretend mode' (Russell, 1997) or both. Even though these impairments are early occurring and universal in autistic children, they are not in any way diagnostic. Such impairments are documented in Aspergers's syndrome (Ponnet et al, 2004) and in pervasive developmental disorder NOS. Parents of children with autism spectrum conditions may also show difficulties in attributing mental states in emotion recognition tasks (Baron-Cohen & Hammer, 1997), suggesting genetic vulnerability and broader cognitive phenotype. As early diagnosis and intervention of these deficits improve performance with limited generalization (Howlin & Hadwin, 1998), study of Theory of Mind deficits in pervasive developmental disorders may lead to fruitful clinical and research avenues.

2.5.2. ToM & Schizophrenia

Theory of Mind in individuals with schizophrenia is compromised because of their failure to monitor their own and other persons' mental states and behaviour, which may

account for many positive and negative symptoms in schizophrenic disorders (Frith, 1992). There are alternative views, which construe ToM deficits as a result of executive function deficits (Hardy-Bayle´ & Sarfati, 2003) or even hyper ToM in schizophrenia causing psychotic symptoms (Abu-Akel, 1999). Specialized tests have been designed to test ToM abilities in schizophrenia (Frith & Corcoran 1996; Langdon et al. 1997; Sarfati et al.1997). There is good empirical evidence for ToM deficits in schizophrenia and that many psychotic symptoms may best be understood in light of a disturbed capacity in patients to relate their own intentions to executing behaviour, and to monitor others' intentions (Brune, 2005). Similar deficits phenomenologically manifests as schizotypy with psychotic like traits and impoverished social awareness of variable expression and severity which denote high vulnerability for psychotic disorders (Langdon & Coltheart, 1999). However, it is still debated how an impaired ToM in schizophrenia is associated with other aspects of cognition, whether it is a state or trait variable, and how this affects the patients' use of language and social behaviour. In addition to these potential research areas, future studies need to address whether patients could benefit from cognitive training in this domain.

2.5.3. ToM & Mood disorders

ToM research in mood disorders awards enthralling etiological and therapeutic implications. Akin to schizophrenia, theories of mind deficits were documented in bipolar affective disorder during episodes (Kerr & Bentall, 2003) and during remission (Bora, et al, 2005). This adds to mounting academic argument that common causative mechanisms may contribute to bipolar affective disorder and schizophrenia. ToM deficits are also present in unipolar depression during episodes (Lee et al, 2005) and during remission (Inoue et al, 2004). Depressed individuals have difficulty to identify and decode others' social cues and perform poorly in second order false belief and

emotion recognition tasks. Such deficits admonish a decline of skilful social relationships. Strategies based on improving basic ToM reasoning could be incorporated into current therapeutic interventions for depression to provide better social adjustment.

2.5.4. ToM & other disorders

Theory of mind impairment is extensively studied in divergent clinical conditions such as Alzheimer's dementia (Gregory, et al, 2002), acquired neurological lesions (Damasio, 1994), seizure disorder (Farrant, et al, 2005), delusional disorder (Craig, et al, 2004), intellectual disability (Yirmiya et al., 1998), behavioural disorders (Hughes & white, 1998), Attention Deficit Hyperactivity Disorder (Papadopoulos, et al., 2005), personality disorders (Dolan & Fullam, 2004), child sexual offenders (Keenan & Ward, 2000), normal aging (Happe & Brownell, 1998) and deaf mutism (Courtin & Melot, 2005). This highlights the fact that ToM impairment is widely prevalent and has high clinical and research priority.

2.6. ToM & COGNITION

Is Theory of Mind an independent valid specific cognitive ability or a part or product of general cognitive abilities? This controversy exists from the commencement, because some *executive function based theorists* contend that a distinct Theory of Mind ability does not exist. These theorists instead believe that executive functions are sufficient to perform the mental inferencing skills attributed to Theory of Mind, without the participation of any specialized cognitive skill (Hughes, 1998; Ozonoff et al., 1991). They reject a Theory of Mind construct arguing that the tasks used to assess Theory of Mind ability primarily test executive function component skills such as set-shifting and response inhibition. The core, meta-representational ability attributed to Theory of

Mind by modularity theorists is also merely interpreted as one example of the general cognitive capacity for using embedded rules (Frye & Palfai, 1995). The endeavours till date to resolve this debate have indeed granted clinical, neuro psychological and research evidence providing strength to both sides of this controversy.

2.6.1. Evidence against ToM as a specific cognitive domain

The following studies in healthy and in psychiatrically ill individuals support the view that Theory of Mind is a part or product of general cognitive abilities. When two groups of children were independently trained in Theory of Mind skills and in executive functions, both trained groups showed significant improvement in performance on Theory of Mind tasks in comparison with a control group (Fisher & Happe, 2005). A review of studies on moral judgments established a bidirectional relationship with Theory of Mind and argued that moral judgments actually serve as input to the process underlying the application of Theory of Mind concepts (Knobe, 2005). Another review of neuro imaging studies of attempted deception tasks found out activation of prefrontal and anterior cingulate cortices, which are principally associated with executive functions (Spence, et al., 2004). Theory of Mind deficits in schizophrenia found to be related to domain general impairments, intelligence and working memory load, rather than reflecting a genuine compromised mental state attribution (Brune, 2003). In a study of ToM deficits in patients with fronto temporal dementia and Alzheimer's dementia reveal that Theory of Mind deficits correlate with the neuro psychiatric inventory scores (Gregory, et al., 2002). These studies point towards a significant correlation between Theory of Mind deficits and general cognitive deficits. Analogous executive function and Theory of Mind developmental timelines in children and the obscurity inherent in experimentally differentiating Theory of Mind skills from general cognitive skills add to this controversy.

2.6.2. Evidence for ToM as a specific cognitive domain

Convincing neuro physiological and neuro imaging studies indicate evidence of specific localization of Theory of Mind ability and selective Theory of Mind impairment with spared executive function component skills in pervasive developmental disorders and in acquired neurological lesions. They contradict the claims of general executive function based explanation of Theory of Mind. In a study investigating a link between Theory of Mind and episodic memory, most Theory of Mind abilities showed no interrelations with episodic memory during development (Naito, 2003**)**. Another series of experiments investigating the models regarding the role of the amygdala in the development of theory of mind and the degree of dissociation between theory of mind and executive functioning, concluded that theory of mind is not simply a function of more general executive functions and that executive functions can develop and function on-line, independently of theory of mind (Fine & Blair, 2001). Evolutionary history of prefrontal cortex also indicates the cognitive specialization of Theory of Mind ability (Povinelli & Preuss, 1995).

The abnormal development of social cognitive component of ToM among autistic children is hypothesized as abnormal functioning of the specific orbito frontal and medial temporal circuits (Sabbagh, 2004). Patients, who have temporo parietal junction lesion with intact frontal lobes, present belief reasoning errors with spared executive functions which hoist the possibility that this brain region may have a role in ToM, rather than handling the executive demands (Apperly, et al., 2004). Another study of Theory of Mind in adults who had suffered right hemisphere stroke, documented pragmatic and social difficulties and established that such impairment on ToM tasks was not a function of task difficulty. It supported the notion of a dedicated cognitive system for theory of mind, and suggested a role for the healthy right hemisphere in

ToM (Happe, et al., 1999). In short, even though, any break through evidence to clearly demarcate theory of mind as an independent cognitive domain distinguished from general cognitive abilities has not so far emerged, there is enough available evidence to pose such claim.

2.6.3. ToM & Language ability:

There is a wealth of literature investigating the relationship between Theory of Mind ability and general language ability. In contrast to visuo spatial ability, language consistently correlates with social understanding (Tager- Flusberg & Sullivan, 1994). Direct studies have established that general language ability is more related to false belief tasks than semantics and syntax, per se (Ruffman, et al., 2003). Even the knowledge of a second language significantly improves young children's understanding of mental representations (Berguno & Bowler, 2004).

In three available longitudinal studies about the relationship between language and Theory of Mind, two studies (Astington & Jenkins, 1996; De villiers & Pyers, 2002) reported early language development predicted later theory of mind development whereas the reverse relationship rarely held. One study found out a bidirectional relationship between language and theory of mind development. It added that such relationship was robust even after accounting for the children's age and the verbal complexity of the tasks employed (Slade & Ruffman, 2005).

Semantic and syntactical language abilities have been postulated to be correlated with explicit components of Theory of mind ability. It has been hypothesized as Theory of Mind, or at least, the social knowledge initially develops in an implicit form and only later becomes explicit. Initial implicit Theory of Mind insights occur through statistical learning processes involving gradual piecing together of various bits of social information (Boucher & Dienes, 2003). Once, the implicit understanding is in place,

children develop better explicit Theory of Mind skills depending on the extent of their language skills which provide the terminology to reflect on and refine implicit intuitions (Ruffman, et al., 2003; Hale &Tager-Flusberg, 2003). The major confounding factors in these studies are children's chronological age, intelligence and their interactions and period effects with general language ability.

2.7. ToM & Intelligence:

Intelligence is broadly conceptualized as an overall ability for learning and problem solving. There is no single universally accepted definition for intelligence (Barett & Breuning, 1983). It is operationally defined, "Intelligence is the aggregate or global capacity of the individual to act purposefully, to think rationally, and to deal effectively with his environment" (Wechsler, 1958). They are various theories describing the nature of intelligence which can be broadly classified as factor theories and process oriented theories (Morgan& King, 2002). Intelligence may be expressed as Intelligence Quotient (IQ) which is a ratio between a particular score an individual attains and the score which an average individual of his age may be assumed to attain on the same test. William stern first proposed the concept of intelligence quotient in 1912. IQ is usually documented as a percentage score of a ratio between mental and chronological age. There are many well-standardized test batteries available at present to quantify IQ and to identify verbal and non-verbal performance IQ.

2.7.1. Importance of the relationship between ToM & IQ

Akin to the debate on Theory of Mind and general cognitive abilities, the relationship between Theory of Mind and Intelligence is also complex as well as controversial. The relationship between IQ and Theory of Mind is usually addressed in recent research under two contexts. First, there is enough accumulated evidence about Theory of Mind

deficits in children with intellectual disability and about relatively more pronounced Theory of Mind deficits in children who have the co morbidity of low IQ and psychiatric disorders such as autism and psychosis. Secondly, most Theory of Mind investigators favour matching their sample on IQ or accounting for the role of IQ with regression analysis to bye pass this fundamental issue while dealing with more advanced research quests. Despite the fact that intelligence is considered to be one of the prime confounding factors in any sort of Theory of Mind assessment, the existing literature regarding the direct relationship between IQ and Theory of Mind abilities is strangely sparse.

Available studies argue for a model of chronological age, verbal IQ, paternal education, maternal mental state language (Adrian, et al., 2005) and for a model of verbal memory, performance IQ, age and gender (Buitelaar, et al., 1999b), as the best predictors of variables of Theory of Mind ability. A study of relationship between Wechsler IQ profile and Theory of Mind in autistic children, comprehension sub test had stronger correlation with Theory of Mind ability than block design subtest (Happe, 1994). A well-validated TOM test scores has been found to be positively associated with Wechsler Intelligence Scale for Children IQ scores (Muris, et al, 1999). Another study failed to find any significant correlation between IQ and The Eyes Test values in unaffected first-degree adult relatives of schizophrenia (Kelemen, et al., 2004). A preliminary investigation indicates that even male hormones and Body Mass Index may predict Theory of Mind abilities and they have a negative correlation with ToM and crystallized intelligence (Azurmendi, et al. 2005).

2.7.2. ToM & intellectual disability:

Theory of Mind research in children with intellectual disability has focused on three major areas. They are the validity of Theory of Mind assessment tests in children with

compromised intelligence, the extent of Theory of Mind deficits in such children in comparison with normal controls and those with psychiatric morbidity and the disparity of those deficits among different aetiologies of intellectual disability.

A Meta analysis of theory of mind studies in children with intellectual disability asserts that Theories of Mind deficits are prominent in children with intellectual disability (Yirmiya et al., 1998). Adolescents with intellectual disability performed worse than children without intellectual disability even when they were matched for mental age. They performed better on first order false belief tests than on second order false belief tests (Benson, 1993). Individuals with schizophrenia and pre morbid intellectual disability showed greater impairment of Theory of Mind skills than those with schizophrenia alone (Doody, et al., 1998).

Such Theory of Mind deficits differ depending on various aetiology of intellectual disability. Theory of mind can be selectively spared relative to general cognitive functions in cases of Down's syndrome and Prader Willi syndrome. Social cognition impairments of children with fragile X syndrome were also reported (Cornish, et. al., 2005). How ever, the deficits in Down's syndrome were more global and severe than those of fragile X syndrome (Abbeduto L, 2001). There is a conflict of evidence for (Tager- Flusberg & Sullivan, 2000) and against (Sullivan & Tager-Flusberg, 1999) specific social cognitive component impairment in children with Williams syndrome. Children with poor control of Phenyl ketonuria (PKU) were found to be similar to autistic children in relation to dopaminergic dysfunction and Theory of Mind impairment (Dennis, et al., 1999).

Moderate reliability was established across a series of three false belief tasks and two belief desire reasoning tasks in a study to test the reliability of theory of mind task performance by individuals with intellectual disability (Charman & Campbell, 1997).

Children with intellectual disability have limited narrative language skills which substantially contribute to their failure on the false belief task. Screening out children who failed to meet linguistic and cognitive prerequisites for dealing with the performance demands of the false belief task yielded only non significant correlations between false belief performance and the verbal IQ (Abbeduto, et al., 2004). Further work investigating the psychometric properties of similar tasks is required with both typically and atypically developing children, given the important interpretations made regarding the Theory of Mind skills of children on the basis of their responses in such experimental tasks

2.7.3. ToM & children with above average IQ

Theories of Mind investigators are mostly curious to study the high IQ children with Autism or Asperger's syndrome to document the selective impairment of Theory of Mind faculty (Beversdorf, et al., 1998). Theory of Mind research in psychologically healthy children with average and above average IQ is almost exclusively sited beyond the boundaries of medical literature. This reality deprives the study of Theory of Mind by at least two ways. First, we miss a wealth of data regarding the development, nature and pragmatic applications of Theory of Mind in a population, which is less contaminated by other confounders. Next, we neglect the need of aiding the field of education with appropriate evidence based information. This virtual lack of medical literature on this topic may be due to widely prevalent myths such as children with above average IQ represent a homogenous population and high IQ children are smart, so they can get by on their own. How ever, the available studies have established that high IQ students are not homogenous and providing differentiated instruction is a necessity, even in advanced classes (Parke, 1989). They also suggest that they learn better when high IQ students' abilities and interests are stimulated by the appropriate

level of challenge (Caine & Caine, 1991) and their brain will maintain its level of development only if such students are appropriately cognitively challenged (Clark, 1997).

Second-order thinking or Meta cognition is important for the development of critical thinking and self-reliant learning. Teaching specific social interactional and conversational skills and providing explicit and systematic instruction in the underlying social cognitive principles necessary to infer the mental states of others have shown effectiveness in the performance on Theory of Mind tasks (Ozonoff & Miller, 1995). However, this aspect is generally not given its due priority while planning education programs, especially for the gifted students (Starko & Schack, 1989).

In the past, the concept of giftedness was associated primarily with high IQ. It was assumed that gifted students were born with high intelligence, were identifiable by their high grades and test scores, and were capable of excelling in all areas of school and of life. These assumptions are still prevalent, although they are beginning to change. Cognitive science, developmental psychology, and new understandings of educational psychology are influencing the way giftedness is defined and conceptualized. It is clear that there are different ways of being gifted rather than a definitive list of gifted qualities. It is logical to assume Theory of Mind abilities will be superior in children who are gifted. Preliminary work with gifted children has also shown that they have better Meta cognitive attitude (Schwanenflugel, et al., 1997). However, this claim has not been validated with systematic studies.

2.8. Indian scenario

Even though, there is a dearth of recent research of Theory of Mind in India, Indian investigators did not fail to contribute to this promising topic. Their work were either a part of cross cultural validation studies of Theory of Mind ability or enthralling

endeavours to explain the neuronal basis for mentalizing and spiritual abilities which were traditionally given high priority in ancient India.

In a cross-cultural study of false-belief understanding in five cultures including India, children crossed the false belief milestone at approximately five years of age in every culture studied (Callaghan, et al., 2005). Another Indian study found out that three and four year old children were unable to make mental real distinction and the affluent children consistently outperformed their deprived counterparts (Wahi & Johri, 1994). Indian neurologists also join their hand in understanding the complexity of theory of Mind by proposing promising neuronal origins for this ability (Abraham, 1999; Hirstein & Ramachandran, 2001).

3. AIMS & OBJECTIVES

The objectives of this study are:

1. To establish the relationship between the Theory of Mind (ToM) and Intelligence Quotient (IQ) in children.

2. To establish the relationship between the Theory of Mind (ToM) and various domains of general intelligence in children.

3. To establish the relationship between Theory of Mind (ToM) and adaptive behaviour.

4. METHODOLOGY

4.1. Study design

This is a cross sectional study.

4.2. Setting

Vellore district lies between 12° 15' to 13° 15' North latitudes and 78° 20' to 79° 50' East longitudes in the state of Tamilnadu, India. The geographical area of this district is 6077 sq. Kim. The total population as per 2001 Census is 34, 77,317. Vellore district has 1891 primary schools among which 400 are in urban area and 1491 are rural primary schools. This study was conducted at Nambikkai Nilayam, which is a facility for children with Intellectual Disability, Christian Medical College, Vellore, and other three private institutes providing care for children with Intellectual Disability in Vellore district. Nambikkai Nilayam is a tertiary care, teaching facility with out any geographically defined catchment area. However, a good proportion of children are not referred from other clinics but come on their own for assessment and management. Nambikkai Nilayam provides both in patient and day care special education programs for the children with intellectual disability. All programs include the parents in therapy and a multi disciplinary team comprising child psychiatrists, clinical psychologists, special educators, occupational therapists, specialist nurses and other support staff are involved in the assessment and management of these children. Nambikkai Nilayam is a part of a general hospital and has consultation and liaison with other clinical specialties for their children whenever indicated. This study also included 12 Governmental and private sector primary schools in Vellore district.

4.3. Sample size estimation

Sample size was estimated with 'Med calc' statistical software. With an alpha error of 0.05, a beta error of 0.2, a priori power of 80% and critical value of two-tailed

correlation coefficient at 0.3, the sample size requirement is estimated to be eighty four to establish the correlation between Theory of Mind and IQ. As we anticipated 20% drop out between the two points of assessment, we decided to recruit at least 100 children for this study.

4.4. Sampling

A convenient sampling method was employed to establish the relationship between theory of Mind and IQ over broad IQ ranges. In this study, we attempted to recruit children in three groups differing on their academic performance, which is considered as a pragmatic proxy measure of IQ. Approximately thirty children were planned to be recruited in each of the three groups. They are children with sub average intelligence, average intelligence and the children with above average IQ.

4.5. Sample population

Children with sub average intelligence were recruited from the above mentioned four facilities providing care for the children with intellectual disability. Normally developing children and the children with above average IQ were recruited from the twelve leading primary schools of Vellore district.

4.6. Selection criteria

As we tend to elucidate the relationship between two entangled cognitive variables, this study desired to keep the confounding variables at the feasible minimum. The selection criteria were as follows,

4.6.1. Inclusion criteria

1. Children from eight to eleven years of age.
2. Children and their caregivers should be willing to participate in the study.

4.6.2. Exclusion criteria

1. Children with any present or past psychiatric morbidity.
2. Children with severe or long term physical illness.
3. Children with neurological deficits such as cerebral palsy, seizure disorder and head trauma.
4. Children with sensory deficits such as visual or hearing impairment.
5. Children with severe behavioural problems.
6. Children with present or past history of long term use of any medication.
7. Children who had already received prior training for Theory of Mind tasks.
8. Children who were not willing to provide their verbal assent to participate in this study.

4.7. Measures

4.7.1. Socio demographic data

A semi structured data collection sheet (Appendix 9.2.) was used specifically in this study to collect data regarding the socio demographic profile, academic profile, medical history, family history, and parental and sibling details.

4.7.2. Binet Kamat Test (BKT)

Among the various intelligence assessment scales, the Stanford Binet scale of intelligence is popularly acknowledged to be the 'test of choice' for measuring IQ (Barett & Breuning, 1983). The Binet Kamat scale of intelligence is the Indian adaptation of the 1934 version of Stanford Binet scale of intelligence (Kamat, 1967). Some of the tests, items and materials were amended to suit Indian conditions, such as Indian coins, typically Indian pictorial scenes, vocabulary and Indian concepts. This scale is suitable to assess intelligence from three years of age to adult level. This scale

measures intelligence under six sub scales namely memory, language, conceptual thinking, reasoning, numerical reasoning, visuo motor coordination and social intelligence. The correlation quotient is nearly 0.5 for the IQ (Kamat, 1967).

4.7.3. Vineland Adaptive Behaviour Scale (VABS)

Vineland Adaptive Behaviour Scale was the primary tool for measure of adaptive behaviour (Sparrow, et al, 1984). It assesses the social competence of individuals with and without disabilities from birth to age 19. There are three versions of the revised VABS, the Interview Edition, Survey Form; the Interview Edition, Expanded Form; and the Class Room Edition. This study employed the Survey form which provides a general assessment of adaptive behaviour which is useful for determining areas of strength and weakness. VABS has 297 items under four major domains and 11 sub domains: *Communication*, which has expressive, receptive and written sub domains, *Daily Living Skills*, which has personal, domestic and community sub domains, *Socialization,* which has interpersonal, play & leisure and coping sub domains and *Motor Skills* which has fine and gross motor sub domains. An *Adaptive Behaviour Composite* is a combination of the scores from the four domains. The 12 page survey form record booklet is used by the trained interviewer to record item scores and informal observations. It has a score summary page for recording and profiling derived scores. The Survey Form Manual provides detailed information necessary to administer and score the Survey Form and to interpret the results. The manual also contains technical information about development and standardization. For each of the four Adaptive Behaviour domains and Adaptive Behaviour Composite, standard scores, percentile ranks, stanines, adaptive levels, and age equivalents are given. For each of the sub domains, the user may determine adaptive levels and age equivalents. The

optional Maladaptive Behaviour domain of the Survey Form determines maladaptive levels.

VABS has good internal consistency, test-retest reliability, and inter rater reliability. Two statistics were typically used to report reliability – the reliability coefficient and the standard error of measurement (SEM). The test-retest reliability coefficients for the domains and adaptive behaviour composite are very good, with the majority of the coefficients in the .80s and .90s. For the adaptive behaviour composite, test-retest and inter rater reliability coefficients were .99 and .98 respectively. Median correlations between pairs of domains ranged from .39 to .55, indicating only a modest overlap among the domains.

4.7.4. Strength Difficulties Questionnaire (SDQ)

The strength difficulty questionnaire (Goodman, 1997) is a brief questionnaire to screen for psychological strengths and child psychiatric disorders in a community sample. SDQ has been translated in more than 40 languages, including Tamil. Computerized algorithms are available to predict psychiatric disorders with the information obtained from SDQ. SDQ has three versions, care giver version for children aged 3–4, parent/ teacher version for children aged 4-16 and self report version for children aged 11- 16. This study employed the parent/ teacher version of SDQ meant for children aged 4 – 16. It has 25 items which refer to different emotions or behaviours. For each item the respondent marks in one of three boxes to indicate whether the item is not true, somewhat true or certainly true. Somewhat true is always scored 1, but whether not true and certainly true are scored 0 or 2 depends on whether the item is framed as a strength or difficulty. The overall score indicates whether the child is likely to have a significant problem by placing the child in one of the three categories, high needs, some needs and

low needs among five subscales for Pro-social Behaviour, Hyperactivity, Emotional Symptoms, Conduct and Peer problems. This is useful to employ further diagnostic assessment for high needs children and to plan treatment with the special consideration of their strengths. SDQ can identify children with psychiatric morbidity with a specificity of 94.6% and a sensitivity of 63.3% and can identify more than 70% of children with conduct, hyperactivity, depressive and anxiety disorders (Goodman, et al., 2000).

4.7.5. Picture Sequencing Task (PST)

Picture sequencing task measures the Theory of Mind by assessing false belief reasoning and general sequencing ability. The PST employed in this study was adapted with the permission and the guidance of Dr. Robyn Langdon, cognitive psychologist, Macquarie University, Sydney, who developed and extensively used the original version in her Theory of Mind research endeavours (Langdon & Coltheart, 1999).

PST employed 14 sequences which included two practice, four false belief, four mechanical and four social script sequences. Each sequence was made up of a series of four pictures made up of black and white sketches. These sequences were presented to all children in a same prefixed order. The pictures within a sequence were shuffled with out the knowledge of the child and the child was asked to reorganize them in a meaningful order. The reorganized order and response time for each sequence were recorded. If the child placed the first or the last pictures in their correct position, he/ she received two points each. One point each was awarded for placing the middle ones in their correct position and hence, a total of six points were given for correctly reorganized sequence. There were no points for the first two practice sequences.

Means of scores obtained and mean response times for false belief, mechanical and social script sequences were calculated separately. Averaging the mean scores of

mechanical and social script sequences derived a general sequencing ability. A selective accuracy measure of Theory of Mind ability was calculated by subtracting the general sequencing ability from the mean score obtained from false belief sequences. Similarly, a selective time measure was calculated in the same way using the mean response times.

PST is a relatively novel experimental task and the psychometric properties of this task have not yet been evaluated in depth. The discriminant validity and construct validity of PST has been demonstrated in studies of Theory of Mind functioning in schizophrenia (Harrington, et al., 2005). There are no test-retest reliability statistics currently available. Yet, PST was considered to be the most appropriate test for this study in view of the following rationale,

1. PST places less demand on general language ability and working memory, which are known confounders in any Theory of Mind assessment.
2. Selective accuracy measure of Theory of Mind ability obtained from PST, is disentangled from the general sequencing ability and has more conceptual authenticity.
3. PST provides an objective outcome of Theory of Mind ability as a single continuous numerical variable, akin to IQ and is more suitable for correlation analysis.
4. PST uses simple sketches, which lack exquisite details, and appears less culturally unfair for Indian children.
5. Such simple pictures and less demand on language ability and working memory allow participation of children with intellectual disability and valid use of one single uniform test among children over broad IQ ranges.

However, the need for further psychometric evaluation of most of Theory of Mind assessment tasks, including the PST cannot be denied and is indeed desired.

4.7.6. Unexpected contents Theory of Mind Task

Even though tests of deception are simple, and brief, they are valid indicators of Theory of Mind functioning. The "Unexpected contents Theory of Mind Task" employed in this study was creative, but it followed a set of questions used in previous studies (Zelazoa, et al., 2002). The child was offered the carton of a crayon box, which had pictures of crayons over it. At first, he/ she was asked to tell about the contents of the box without opening it. Most of them answered that the box contained crayons but were tricked when they opened the box and found two erasers in side. They were asked to name the real contents and were once again asked what they thought being inside when they had first seen that box. They were also asked what another child would answer about the contents of the box if he/ she had not opened that. Their answers to these four questions were considered as appearance, reality, representational change and false belief variables and were scored with one point each for every correct response. This deception task was used to screen the ability of the children to participate in further assessment and to gain additional information regarding their Theory of Mind ability.

4.8. Assessment

Selected children were assessed in two sessions, either at their treating facilities or at their school. Each session lasted for approximately 60 – 90 minutes. During the first assessment session, the principal investigator of this study, obtained the informed consent, collected the socio demographic data and employed the Strength Difficulty Questionnaire parent/ teacher version and unexpected contents Theory of Mind task. Further assessment with Picture Sequencing Task was carried out only if the child was

devoid of psychiatric morbidity as evidenced by low needs in SDQ and was able to participate in Theory of Mind assessment tasks as arbitrarily defined by a score of two or more in unexpected contents Theory of Mind task. Order of sequencing and response times were recorded for every sequence of PST.

Second assessment session was carried out by an independent co investigator, a senior faculty of our department, who possessed more than 25 years of experience in the field of special education. Blinded to the Theory of Mind ability of the child, he employed Binet Kamat Test for intelligence and Vineland Adaptive Behaviour Scale for adaptive functioning. Those results remained blinded to the principal investigator till the end of final statistical analysis.

4.9. Ethical considerations

Children and their parents or guardians were explained about the nature and purpose of this study, procedure to be followed, expected duration of involvement and the possible benefits of this study, by the principal investigator. Verbal assent from the participating children and written informed consent in a specific consent form (Appendix 9.1) from the parents were obtained before recruitment. They were assured of the confidentiality of their personal information and findings and were informed that this information would be processed only for the research purposes in connection with this study. The data was protected by reversible anonymisation to ensure confidentiality. The parents were also educated about their right to withdraw their consent at any point of time without any prior notice. The protocol of this study was presented to and was approved by the institutional review board of Christian Medical College, Vellore.

4.10. Data analysis

The data were analysed at three levels. Firstly, the socio-demographic data, cognitive profile, adaptive behaviours and ToM details for the study sample were analysed using descriptive statistics.

Secondly, the socio-demographic data, cognitive profile, adaptive behaviours and ToM details between groups with different levels of IQ were analysed using parametric tests, because the obtained data were not significantly skewed. Chi-square tests for categorical measures and one-way ANOVA for continuous variables were carried out. The linear correlation between the ToM and various domains of IQ was analysed using Pearson's correlation coefficient tests with two tailed assumptions.

Thirdly, the linear correlation between the ToM and various domains of IQ was analysed using two tailed partial correlation test to control the possible confounders, which significantly differed between the three groups. Also, with ToM as the dependent variable and IQ as the independent variable as well as, chronological age, parent's education, type of school, number of siblings and monthly income as possible confounders for ToM because of the baseline differences between groups, multiple linear regression analysis was conducted. All tests used a two tailed analysis and a P value of less than 0.05 was considered significant. The data analysis was conducted using the statistical software package, SPSS 11.0.

5. RESULTS

5.1. Sample flow

All the 105 children who met the selection criteria were invited to take part in the study. All of them consented to participate and underwent the first assessment session. The children with sub-average intelligence were recruited from four institutes caring for children with intellectual disability. The children with average and above average intelligence were recruited from twelve primary schools in the Vellore district.

5.2. Sample attrition

However, only 95 children completed the second assessment session, because the parents of four children withdrew their consent, four children lost to follow up because of changing their residence to places outside the catchment area, and two children were excluded when the past history of seizure disorder was made available. The overall dropout rate was 9.52%.

5.3. Sample characteristics

The socio demographic profile of the children and their families, who participated in this study, was presented in table I and table II respectively.

Table I: Socio demographic profile of children (N=105) participated in this study.

VARIABLE	N (%)
Gender	
Male	47 (45)
Female	58 (55)
Chronological age (in years)	Mean (SD) 10.19 (0.86)
Religion	
Hindu	89 (84)
Christian	2 (2)
Muslim	14 (13)
Language	
Tamil	79 (75)
Bengali	3 (3)
Others	23 (22)
Birth order	
First	63 (60)
Middle	10 (10)
Last	32 (30)
Type of school	
Special	5 (5)
Private	65 (62)
Government	30 (29)
No formal education	5(5)
Medical illness during the past 1 month	1 (1)
Present	104 (99)
Absent	

The mean age of the participants was 10.19 (SD = 0.86) years. There were 47 (45%) boys and 58 (55%) girls in this study, thus there was a mild female preponderance in this study. Most of them spoke Tamil (75%), belonged to Hindu (84%) religion, and studied in private (62%) schools. A very little number of participants (1%) had any medical problems or consumed any medication within one month of assessment.

Table II: Socio demographic profile of families of children (N=105) participated in this study.

VARAIABLE	N (%)
Type of family	
Nuclear	88 (84)
Joint	16 (15)
Broken	1 (1)
Father's age (in years)	Mean (SD) 40. 92 (6.30)
Father's education	
Illiterate	6 (6)
Primary	8 (8)
Middle	7 (7)
High school	19 (18)
Higher secondary	16 (15)
Graduate	34 (32)
Professional	15 (14)
Mother's age (in years)	Mean (SD) 34.93 (5.19)
Mother's education	
Illiterate	6 (6)
Primary	15 (14)
Middle	8 (8)
High school	18 (17)
Higher secondary	13 (12)
Graduate	36 (34)
Professional	9 (9)
Number of siblings	
Nil	16 (15)
One	60 (57)
Two	23 (22)
More than two	6 (6)
Monthly income (in Rs)	Mean (SD) 13910 (20013)
Family history	
Psychiatric morbidity	3 (3)
Intellectual disability	5 (5)
Seizure disorder	3 (3)
No neuro psychiatric morbidity	94 (89)

Most of the children were from nuclear (84%) middle socio economic status families but there was large variation in their monthly income (Mean Rs. 13910; SD = 20013). The majority of children had literate parents (94%), less than two siblings (94%) and lacked any significant family history of neuro psychiatric morbidity (89%).

5.4. Psychological measures of the participants.

The mean IQ of the participants was 92.76 (SD = 29.04) with a range of 32 to 144. The picture sequencing task and Binet Kamat Test of intelligence profile of the overall sample was as follows:

Table III: Psychological variables of children participated in this study.

MEASURE		MEAN (SD)
Picture Sequencing Task (N=105)	Social script	4.07 (1.78)
	Mechanical	3.85 (1.71)
	False belief	3.20 (1.47)
	General Sequencing Ability	3.96 (1.64)
	Theory of Mind ability	- 0.75 (1.30)
Binet Kamat Test (N=95)	MA (in years)	9.53 (3.12)
	Language (in years)	10.01 (3.52)
	Meaningful memory (in years)	9.23 (2.66)
	Non meaningful memory (in years)	8.34 (2.72)
	Conceptual thinking (in years)	10.99 (2.24)
	Non verbal thinking (in years)	8.89 (4.36)
	Verbal reasoning (in years)	12.32 (1.09)
	Non verbal reasoning (in years)	9.25 (2.98)
	Visuo motor (in years)	8.90 (1.87)
	Social intelligence (in years)	9.76 (2.91)
	Intelligence Quotient (IQ)	92.76 (29.04)

The Vineland Adaptive Behaviour Scale (VABS) adaptive measures were presented in table IV.

Table IV: Adaptive variables of children (N = 95) participated in this study

ADAPTIVE BEHAVIOUR DOMAIN	MEAN AGE EQUIVALENT IN MONTHS (SD)
Communication	99.64 (36.77)
Receptive	82.33 (22.90)
Expressive	87.72 (30.07)
Written	100.09 (38.35)
Daily living skills	106.73 (37.09)
Personal	139.80 (64.72)
Domestic	102.79 (39.53)
Community	100.95 (37.36)
Socialization	106.53 (44.36)
Interpersonal relationships	104.03 (44.17)
Play & leisure time	89. 78 (35.70)
Coping skills	124.26 (58.18)
Motor (n=23)	51.50 (13.09)
Gross motor	55.48 (17.55)
Fine motor	49.35 (15.01)
Adaptive Behaviour composite (ABC)	**104.8 (37.38)**

The data from Strength Difficulties Questionnaire (SDQ) was recoded in to three categorical variables, as low needs, some needs and high needs, according to the guidelines. All the participants presented as low needs on hyper activity, conduct problems, emotional symptoms, peer problems and total difficulties domains and had favourable scores on pro social domain (mean 9.14; SD=0.86) which efficiently screened out psychiatric morbidity among them, as shown in table V.

Table V: Strengths and Difficulties Questionnaire profile of the children (n=105).

Scale	N (%)
Pro social : Low needs Mean (SD)	105 (100%) 9.14 (0.86)
Hyper activity: Low needs	105 (100%)
Conduct problems: Low needs	105 (100%)
Emotional symptoms: Low needs	105 (100%)
Peer problems: Low needs	105 (100%)
Total difficulties: Low needs	**105 (100%)**

5.5. Socio demographic characteristics between groups

Socio demo graphic profiles of three groups of children with, sub average (N=33), average (N=31) and above average IQ (N=31) were compared in table VI and table VII.

Table VI: Comparison of socio demographic profile of children among three groups.

VARIABLE	SUB AVERAGE IQ	AVERAGE IQ	ABOVE AVERAGE IQ	χ^2 / F[a], df	p
Gender Male Female	 15 18	 17 14	 10 21	2.87, 2	0.2
Age in years Mean (SD)	10.16 (0.74)	10.70 (0.59)	9.85 (0.89)	10.28, 2	**0.001**
Birth order First Middle Last	 20 5 8	 21 2 8	 18 0 13	7.46, 4	0.1
School Private Govt. No formal education	 9 19 5	 20 2 8	 31 0 0	39.01, 4	**0.001**
Medical illness Present Absent	 1 32	 0 0	 0 0	1.87, 2	0.4

[a] = Test conducted were Chi-square test for categorical and one-way ANOVA for continuous variables.

Table VII: Comparison of socio demographic profile of families of children among three groups.

VARIABLE	SUB AVERAGE IQ	AVERAGE IQ	ABOVE AVERAGE IQ	χ^2 / F[a], df	p
Family: Nuclear	29	24	25		
Joint	3	7	6	4.02, 4	0.4
Broken	1	0	0		
Father's age in years Mean (SD)	40.45 (8.56)	40.35 (4.60)	42.42 (5.62)	1.41,2	0.2
Father's education					
Illiterate	6	0	0		
Primary	6	1	0		
Middle	4	2	0	53.88,	**0.01**
High school	8	7	1	12	
H. secondary	5	4	4		
Graduate	3	15	15		
Professional	1	2	11		
Mother's age in years Mean (SD)	32.64 (6.06)	35.61 (4.86)	37.16 (4.17)	7.11, 2	**0.001**
Mother's education					
Illiterate	5	1	0		
Primary	10	3	0		
Middle	5	2	0	45.55,	**0.001**
High school	5	6	3	12	
H. secondary	5	4	3		
Graduate	3	13	18		
Professional	0	2	7		
Number of siblings					
Nil	3	4	7	16.10, 6	**0.01**
One	16	16	23		
Two	10	10	1		
More than two	4	1	0		
Monthly income in Rs Mean (SD)	2874 (4786)	12048 (17598)	26725 (21909)	17.89, 2	**0.001**
Family history					
Psychiatric	1	1	0	4.36, 6	0.6
Intellectual disability	3	1	0		
Seizure	1	1	1		
Nil	28	28	30		

[a] = Tests conducted were Chi-square test for categorical and one-way ANOVA for continuous variables; H. secondary= Higher secondary.

Due to convenient sampling and their inherent predispositions, three groups had significantly differed in many socio demographic variables, such as chronological age (P= 0.001), type of school (P= 0.001), monthly income (P= 0.001), father's education (P= 0.01), mother's education (P= 0.001), number of siblings (P= 0.01) and mother's age (P= 0.001). However, these groups did not significantly vary on gender, birth order, father's age, type of family, presence of medical illness, and on their family history of neuro psychiatric morbidity.

5.6. Psychological measures between groups

As these groups were principally categorized according to their IQ scores, they were bound to differ significantly on their Intelligence profile and indeed; they differed significantly (P= 0.001) on all domains of Binet Kamat Test of Intelligence. Tests on verbal reasoning domain were not possible with most of the children with sub average intelligence and they were employed only in the other two groups. There was similar significant (P= 0.001) difference among the measures of Picture Sequencing Task, including the mean scores of false belief, social script and mechanical sequences, the general sequencing ability and the selective accuracy measure of Theory of Mind ability. Those results were revealed in table VIII.

These groups also varied significantly (P= 0.001) on all domains and sub domains of Vineland Adaptive Behaviour Scales predictably because of the IQ based categorization of the sample. Table IX exhibits the contrast among the adaptive measures of three groups. Age equivalents for motor domain and fine motor and gross motor sub domains were available only for the children with sub average intelligence and so they were not presented in the table.

Table VIII: Comparison of psychological profile of children among three groups.

DOMAIN	SUB AVERAGE IQ Mean (SD)	AVERAGE IQ Mean (SD)	ABOVE AVERAGE IQ Mean (SD)	F (df=2)	p
Social script	2.69 (1.88)	4.94 (0.93)	4.94 (1.03)	30.35	**0.001**
Mechanical	2.32 (1.34)	4.89 (1.04)	4.84 (1.03)	52.80	**0.001**
False belief	1.89 (0.92)	3.41 (1.17)	4.54 (0.97)	56.44	**0.001**
GSA	2.50 (1.49)	4.92 (0.78)	4.89 (0.91)	50.72	**0.001**
Theory of Mind	-0.61 (1.51)	-1.50 (1.17)	- 0.35 (0.79)	7.86	**0.001**
MA (in years)	5.90 (2.19)	10.64 (0.64)	12.28 (1.21)	153.40	**0.001**
Lang (in years)	6.03 (2.79)	11.29 (1.19)	12.97 (1.02)	119.16	**0.001**
Meaningful memory (in years)	6.36 (2.98)	10.23 (0.72)	10.84 (1.00)	50.71	**0.001**
Non meaningful memory (in years)	5.83 (2.12)	8.90 (0.30)	10.41 (2.78)	39.29	**0.001**
Conceptual thinking (in years)	7.77 (1.01)	10.68 (1.11)	12.65 (1.82)	53.39	**0.001**
NV thinking (in years)	4.58 (1.50)	11.60 (1.27)	12.70 (2.62)	102.03	**0.001**
NV reasoning (in years)	6.47 (1.96)	12.00 (0.00)	12.44 (1.28)	61.67	**0.001**
Visuo motor (in years)	6.60 (2.04)	9.57 (1.07)	9.83 (0.66)	43.56	**0.001**
SI (in years)	6.33 (2.20)	11.35 (1.08)	11.81 (0.60)	137.83	**0.001**
IQ	59.81 (20.93)	99.51 (5.79)	121.09 (8.41)	165.41	**0.001**

GSA- General Sequencing Ability; MA- Mental Age; Lang- Language; NV- Non Verbal; SI- Social Intelligence; IQ- Intelligence Quotient.
[a] = Test conducted was one-way ANOVA as all variables were continuous in nature.

Table IX: Comparison of adaptive profile of children among three groups.

DOMAIN/ SUB DOMAIN	SUB AVERAGE IQ Mean* (SD)	AVERAGE IQ Mean* (SD)	ABOVE AVERAGE IQ Mean* (SD)	F[a] (df=2)	p
Receptive	60.70 (28.25)	93.68 (1.79)	94.00 (0.00)	41.74	**0.001**
Expressive	57.70 (33.45)	101.52 (9.35)	105.87 (4.86)	52.98	**0.001**
Written	58.67 (34.81)	113.68 (13.60)	130.61 (9.45)	87.88	**0.001**
Communication	58.97 (32.73)	114.97 (12.60)	127.61 (7.96)	95.11	**0.001**
Personal	75.97 (43.53)	148.71 (45.56)	198.84 (29.33)	73.53	**0.001**
Domestic	65.82 (39.67)	114.32 (22.08)	130.61 (17.03)	44.83	**0.001**
Community	63.39 (39.51)	114.35 (8.58)	127.52 (12.93)	58.81	**0.001**
Daily living skills	67.88 (35.54)	118.48 (11.91)	136.32 (10.69)	76.30	**0.001**
Inter personal	60.21 (33.54)	115.19 (24.14)	139.52 (28.07)	64.55	**0.001**
Play & Leisure	52.48 (31.93)	103.19 (14.49)	116.06 (16.31)	71.85	**0.001**
Coping skills	62.52 (53.97)	145.35 (22.24)	168.90 (17.11)	77.35	**0.001**
Socialization	58.48 (38.45)	122.16 (15.06)	142.03 (16.36)	90.23	**0.001**
Adaptive behaviour Composite	63.70 (32.89)	118.29 (12.07)	135.10 (9.11)	98.19	**0.001**

* Mean of age equivalents in months

[a] = Test conducted were Chi-square test for categorical and one-way ANOVA for continuous variables.

5.7. Bivariate correlation between ToM and IQ

When the continuous variables of Theory of Mind and intelligence Quotient were analyzed for their bivariate linear correlation with two tailed Pearson correlation coefficient, there was no significant (P= 0.2) relationship between ToM and IQ. Further analysis for the linear relationship between various domains of intelligence and ToM revealed that ToM had significant correlations with visuo motor (P=0.02) and social intelligence (P=0.003) domains. They were summarized in table X.

Table X: Bivariate correlation between Theory of Mind ability and intelligence domains (N=95).

DOMAIN	r[a]	P
Language	-0.16	0.1
Meaningful memory	-0.20	0.06
Non meaningful memory	-0.14	0.2
Conceptual thinking	0.21	0.08
Non verbal thinking	-0.25	0.07
Verbal reasoning	0.10	0.5
Non verbal reasoning	-0.09	0.4
Visuo motor	-0.26	**0.02**
Social Intelligence	-0.29	**0.003**
Intelligence Quotient	-0.14	0.2

[a] Pearson correlation coefficient (two tailed)

5.8. Partial correlation between ToM and IQ

As there were significant differences of socio demographic and adaptive variables among three study groups, partial correlation analysis was carried out while controlling for the effects of chronological age, mother's age, income, father's education, Mother's education, type of schooling, number of siblings and Vineland Adaptive Behaviour Scale Adaptive Behaviour Composite age equivalent. These variables were chosen due to their statistically significant differences and for their importance of being major confounders as shown in review of literature. Partial correlation analysis also demonstrated no significant relationship between Theory of Mind and Intelligence Quotient and between Theory of Mind and most of the domains of intelligence. However, the Theory of Mind's correlation with visuo motor and social intelligence domains attained more statistical significance with partial correlation.

When this partial correlation analysis was further controlled for the effects of Picture Sequencing task, General Sequencing Ability, Visuo motor domain lost (Partial correlation coefficient = -0.02; P= 0.8) its significant correlation with Theory of Mind ability. However, when this partial correlation was further controlled for Vineland Adaptive Behaviour Scale socialization domain age equivalent, Social Intelligence domain still held a significant correlation (Partial correlation coefficient = -0.36; P=0.001) with Theory of Mind ability. These relationships were depicted in table XI.

Table XI: Partial correlation between Theory of Mind ability and intelligence domains (N=95).

DOMAIN	Rho[a]	P
Language	0.13	0.2
Meaningful memory	-0.17	0.1
Non meaningful memory	-0.01	0.9
Conceptual thinking	-0.05	0.7
Non verbal thinking	-0.05	0.7
Verbal reasoning	0.03	0.9
Non verbal reasoning	0.04	0.7
Visuo motor	-0.29	**0.01**
Social Intelligence	-0.38	**0.001**
Intelligence Quotient	0.01	0.9

Controlled for chronological age, mother's age, income, father's education, Mother's education, type of schooling, number of siblings and Adaptive Behaviour Composite age equivalent.

[a] Partial correlation coefficient (two tailed)

5.9. Analysis of relationship between ToM and IQ within groups

Similar correlation analysis was performed within three study groups. Theory of Mind did not have significant relationship with Intelligence quotient in any group, while accounting for the confounders. In the sub average intelligence group, Theory of mind had significant correlation with non-verbal thinking (P=0.02) and with social intelligence (P=0.003), as revealed in table XII.

Table XII: Partial correlation between Theory of Mind ability and intelligence domains in the sub average intelligence group.

DOMAIN	Rho[a]	P
Language	0.06	0.8
Meaningful memory	-0.08	0.7
Non meaningful memory	-0.28	0.2
Conceptual thinking	-0.75	0.1
Non verbal thinking	-0.56	**0.02**
Verbal reasoning	-	-
Non verbal reasoning	-0.08	0.7
Visuo motor	-0.36	0.2
Social Intelligence	-0.57	**0.003**
Intelligence Quotient	-0.26	0.2

Controlled for chronological age, mother's age, income, father's education, Mother's education, type of schooling, number of siblings and Adaptive Behaviour Composite age equivalent.

[a] Partial correlation coefficient (two tailed)

Even if this analysis was further controlled for General Sequencing Ability, Non-verbal thinking domain held (Partial correlation coefficient = -0.65; P= 0.008) more significant correlation with Theory of Mind ability. Similarly, when this partial correlation was further controlled for Vineland Adaptive Behaviour Scale socialization domain age equivalent, Social Intelligence domain still held a significant correlation (Partial correlation coefficient = -0.51; P=0.01) with Theory of Mind ability. How ever, there were no such significant correlations between any domains of intelligence and Theory of Mind ability in average and above average groups. Those results were presented in table XIII and in table XIV.

Table XIII: Partial correlation between Theory of Mind ability and intelligence domains in the average intelligence group.

DOMAIN	Rho[a]	P
Language	-0.03	0.8
Meaningful memory	-0.26	0.2
Non meaningful memory	0.05	0.8
Conceptual thinking	-0.27	0.2
Non verbal thinking	-	-
Verbal reasoning	-	-
Non verbal reasoning	-0.35	0.09
Visuo motor	-0.26	0.2
Social Intelligence	-0.03	0.9
Intelligence Quotient	-0.27	0.2

Controlled for chronological age, mother's age, income, father's education, Mother's education, type of schooling, number of siblings and Adaptive Behaviour Composite age equivalent.

[a] Partial correlation coefficient (two tailed)

Table XIV: Bivariate correlation between Theory of Mind ability and intelligence domains in the above average group.

DOMAIN	r[a]	P
Language	0.15	0.4
Meaningful memory	-0.03	0.9
Non meaningful memory	0.07	0.7
Conceptual thinking	-0.29	0.1
Non verbal thinking	-0.01	0.9
Verbal reasoning	0.04	0.8
Non verbal reasoning	-0.12	0.5
Visuo motor	-0.05	0.8
Social Intelligence	-0.20	0.3
Intelligence Quotient	0.05	0.8

[a] Pearson correlation coefficient (two tailed)

[#]Partial correlation could not be computed in this group.

5.10. Regression analysis of ToM ability

Theory of Mind ability as dependent variable was explored using multiple linear regression analyses with chronological age, monthly income, father's education, mother's education, type of school and number of siblings as independent variables, because they were not balanced between groups. Multiple liner regression was considered over the logistic regression because of the large number of confounders that needed control and the participant numbers were inadequate for a logistic regression. Thus the theory of mind was treated as a continuous variable in the regression.

Four models were tested with Theory of Mind as the dependent variable. They were one model only with confounders (chronological age, monthly income, father's education, mother's education, type of school and number of siblings), one model with confounders and Intelligence Quotient, one model with confounders and Vineland Adaptive Behaviour Scale Adaptive Behaviour Composite age equivalent and another

model with confounders and Binet Kamat Test social intelligence. Among these four models, the one with social intelligence was most successful in predicting the Theory of Mind ability with statistical significance. These results of regression analysis were summarized in Table XV.

Table XV: Regression analysis of Theory of Mind ability as dependent variable.

MODEL	β (SE)	t	P	R^2
All confounders[a]	-	-	0.09	0.10
Intelligence Quotient[b]	-0.22 (0.01)	-1.45	0.17	0.11
Adaptive Behaviour[c]	-0.21 (0.01)	-1.48	0.16	0.11
Social Intelligence[d]	-0.54 (0.07)	-3.63	**0.004**	0.21

[a] A model comprising chronological age, monthly income, father's education, mother's education, type of school and number of siblings.

[b] A model comprising all confounders and Intelligence Quotient.

[c] A model comprising all confounders and Vineland Adaptive Behaviour Scale Adaptive Behaviour Composite age equivalent.

[d] A model comprising all confounders and Binet Kamat Scale Social Intelligence.

Constant was included in each model.

6.DISCUSSION

6.1. Interpretation of results

To address our first objective, this study has examined the direct relationship between Theory of Mind ability and Intelligence among a sample of 105 psychologically healthy children with a wide range of IQ. It has demonstrated that there was no significant correlation between these two cognitive modalities among the overall sample and within all three groups.

In this study, to focus on the second objective, we also explored the relationship between Theory of Mind ability and various domains of intelligence in children with sub average, average and above average intelligence. Two intelligence domains attained statistically significant correlation with Theory of Mind ability while controlling for the confounders. They were visuo motor and social intelligence domains. The significance of correlation of visuo motor domain could be linked to the general sequencing ability, which was essential for the performance in the Picture Sequencing Task and was not evident in the analysis within all three groups. Nonverbal thinking domain attained significant correlation with Theory of Mind ability only in children with sub average intelligence. Hence, the social intelligence domain can be contended to have the strongest relationship with Theory of Mind ability, especially in children with sub average intelligence.

When we looked at our third objective, adaptive behaviour composite age equivalent was also demonstrated to have no direct relationship with theory of Mind ability. The significant differences among the socio demographic and psychological variables between these study groups, did not account for these findings, as evidenced by the partial correlation and regression analyses. Hence, this study has presented three major findings. First, Theory of Mind ability is not related to general intelligence of a child. Second, Theory of Mind ability is not correlated with most of the intelligence and

adaptive domains. Third, Theory of Mind ability has a strong relationship with social intelligence. These findings argue that Theory of Mind may exist as independent cognitive domain unrelated to intelligence and it has strong association with social intelligence.

6.2. Comparison with previous literature

Previous literature regarding the direct relationship between Theory of Mind and IQ is limited and conflicting and this cross sectional study expands the existing knowledge base on the path of this exciting quest. Theory of Mind is conceptualized to have social perception and social cognition components and Theory of Mind deficits have been documented to result significant social impairment. The finding of relationship between theory of Mind and social intelligence in this study is in line with prior evidence (Tager- Flusberg & Sullivan, 2000).

Studies have argued for (Muris, et al, 1999) and against (Kelemen, et al., 2004) the relationship between Theory of Mind ability and intelligence. They have placed more importance either on verbal IQ (Adrian, et al., 2005) or on performance IQ (Buitelaar, et al., 1999b). These studies were confounded by psychiatric morbidity, sensory deficits and by the effects of psycho tropic medication. By adopting narrow selection criteria, this study has established that Theory of Mind has no significant relationship with various domains of IQ. As this study employed a Theory of Mind assessment instrument, which demanded less of language ability, there was no significant correlation between the language domain and theory of mind ability, which was in contrast with prior literature (Ruffman, et al., 2003).

6.3. Methodological strengths

The present study, to the best of our knowledge, is the first broad based investigation of the direct relationship between Theory of Mind and Intelligence, employing appropriate

methodology and definitely the first such endeavour from developing countries. We believe that the findings of this study can be transferred to other settings, not only in India but also elsewhere.

We recognize that the current study is competent to answer its principal objectives due to the following methodological strengths. First, it was successful in recruiting a sample with narrow selection criteria. It carefully excluded the children with neuro psychiatric morbidity and other physical illnesses and thus created an opportunity to study the Theory of Mind ability in many normally developing children. Second, it studied children over broad IQ ranges and included children with above average IQ. This helped to obtain inputs about this population, which may have valuable implications in planning for their education and medical management. Then, this study calculated an adequate sample size a priori and ensured less than 10% drop out during the study period. Fourth, the data was collected by two independent masked investigators, which reduced the possible biases and augmented the validity of these findings. Fifth, using an assessment task such as Picture Sequencing Task which places less demand on general language ability and working memory and has inbuilt control for general sequencing ability, helped to minimize the effects of these potential confounders. Finally, our data analysis included accounting for possible confounders and the findings held their significance even during partial correlation and regression analyses.

6.4. Methodological Limitations

We acknowledge that this study had to negotiate with many methodological limitations. They include,

1. This study employed convenient sampling, which was prone for inherent biases and resulted in a study population, which was not properly matched on many socio demographic variables.

2. This study was cross sectional and failed to provide the developmental perspectives and the period effects between these cognitive modalities.
3. The academic and research concerns of studying a less confounded sample was traded with clinical concerns of recruiting a more pragmatic and consecutive sample. Employing stricter selection criteria might have compromised the generalizability of these findings.
4. This study ruled out psychopathology with a screening tool and not with structured diagnostic interviews. However, the principal investigator was a qualified psychiatrist and all the participants were first assessed by him before recruitment.
5. Assessment of intelligence and adaptive behaviour was done by the same co investigator and these variables could have influenced each other.

6.5. Clinical implications

The findings of this study have prominent clinical, academic and research implications. First, this study clarifies the independent existence of Theory of Mind ability and its association with social intelligence. This calls for the need to include the evaluation of Theory of Mind during all child and adolescent psychiatry assessments. The documentation of intelligence quotient by standardized test batteries with out separate assessment of Theory of Mind ability may not reflect the real life social competence of the child. Children with average or above average IQ may have low theory of mind ability and vice versa. Hence, an assessment of Theory of Mind is indispensable to understand the child as a whole and to plan for its future care. Second, the functional academics and vocational rehabilitation of children with intellectual disability and psychiatric morbidity should not exclude a package of training on Theory of Mind skills, which will enhance their mentalizing and social skills. Then, possible selective

impairment of Theory of Mind abilities not only in pervasive developmental disorders, but also in mood or psychotic syndromes, indicate the need to pay more attention to this domain during psychotherapy of these disorders. Third, these findings indicate the need for the future studies involving Theory of Mind to control their results for various domains of intelligence, especially social intelligence and not merely for overall IQ. Fourth, the distinct existence of Theory of Mind domain in normal school children has serious implications on designing an appropriate curriculum for them.

6.6. Future directives

Future research on this theme should employ more population based stratified random sampling to minimize biases. A longitudinal study is needed to explore the developmental changes and to obtain the detailed account of relationship between theory of Mind and intelligence. The direct relationship between Theory of Mind and adaptive behaviour can be better elicited if different independent investigators assessed intelligence and adaptive behaviour. There was a lingering need to validate the Theory of Mind assessments tools to obtain reliable results. Generalizability of these findings should be checked across cross-cultural settings. Finally, more neuro physiological and cognitive neuro psychological research is needed to illuminate the complex biological make up of Theory of Mind domain. Then only, the challenge of providing a convincing answer for the relationship between theory of Mind and intelligence or other general cognitive abilities can be conquered.

7. CONCLUSION

1. Theory of Mind (ToM) is the cognitive ability to predict and to explain one's own and others' behaviours in terms of mental states.

2. ToM is vital for successful social functioning, especially for children.

3. Intelligence is considered to be the prime confounding factor in any assessment of Theory of Mind. However, the direct relationship between IQ and Theory of mind functioning has been less studied systematically.

4. It is desirable to establish the relationship between Theory of Mind and IQ, in children over broad IQ ranges, who never had any neuro-psychiatric morbidity unlike the previous studies that have focussed on children with morbidities.

5. Understanding such relationship in children has to be established before the concept could be used for future research and clinical practice.

6. In this study, despite the limitations of convenient sampling and of being cross sectional, we established that Theory of Mind ability is not directly related to intelligence among children.

7. Theory of Mind ability has been found to have significant association only with social intelligence domain.
8. These findings support the view that Theory of Mind exists as an independent cognitive domain unrelated to intelligence, which has many prominent clinical, academic, educational and research implications.

9. Further research on ToM among participants without any psychiatric morbidity but across different age groups as a cohort study is essential to study ToM interaction over time with other cognitive and environmental domains.

10. Currently with the data from this study psychological interventions have to be implemented as separate module from those which focus on improving the mental as well as the social age.

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9. APPENDICES

9.1. INFORMED CONSENT FORM

Title of study:
RELATIONSHIP BETWEEN THEORY OF MIND AND INTELLIGENCE

Institution:
Christian Medical College & Hospital,
Vellore.

Nature and purpose of the study:
You and your child are taking part in a new research which attempts to study the relationship between the general intelligence and the Theory of Mind, an ability to predict and to explain behaviors in terms of mental states.

Explanation of procedure to be followed:
A CMCH doctor and a special educator from the department of child psychiatry will conduct this study. Your child will undergo assessment of his / her intelligence and Theory of Mind skills with the help of some structured questionnaires.

Expected duration of involvement:
The assessment will be done in two sessions. Each session will last about one hour.

Possible benefits of the study:
You will not be charged for this assessment. The information we obtain will help us to assess your child's intellectual ability and theory of Mind skills. Other children may also benefit from the overall conclusions at the end of the study.

Confidentiality
The records and all details obtained in this study will remain strictly confidential at all times, but will need to be available to the doctor conducting the study. Your identity will not otherwise be revealed. Your personal data will be collected and processed only for the research purposes in connection with the study. You will not be referred to by name or identified in any report or publication.

Verbal assent from the child
Verbal assent from the child will be acquired whenever possible.

Right to withdraw from the study
You are free to leave the study at any time. Your decision to not to participate in this study will not affect our future medical care.

Consent
I/We have read/……had read out to us, the above information before signing this consent form.

Signature of the parent/ guardian **Signature of the person obtaining consent.**

Date:

9.2. DATA COLLECTION SHEET.

1. Name of the child :
2. Father/ Guardian's name :
3. Sex : male / female
4. Age (in months) :
5. Area : rural/ semi urban/ urban
6. Religion : Hindu/ Muslim / Christian / Others
7. Mother tongue :
8. Type of family : Nuclear/ Joint/ Broken
9. Father's age (in years) :
10. Father's education : Illiterate/ primary/ middle/ high school/ higher secondary/ graduate/ professional.
11. Father's occupation : Unskilled/ semi skilled/ skilled/ professional
12. Mother's age (in years) :
13. Mother's education : Illiterate/ primary/ middle/ high school/ higher secondary/ graduate/ professional.
14. Mother's occupation : Unskilled/ semi skilled/ skilled/ professional/ House wife.
15. Number of siblings : nil/ one/ two/ more than two
16. Order of birth : first/ middle/ last.
17. Family income per month : Rs.
18. Consanguinity : present/ absent
19. Family history : psychiatric morbidity/ intellectual disability/ seizure disorder/ nil
20. Perinatal insult : present/ absent/ unknown.
21. Developmental delay : present/ absent/ unknown.
22. School : Special/ private/ semi private/ government/ nil.
23. Grade :
24. Previous exam performance: Topper/ within top ten/ average/ within bottom ten/ not applicable.
25. School Conduct : good/ satisfactory/ not satisfactory/ bad.
26. Current medical problems & medications:

PICTURE SEQUENCING TASK:

SERIAL NO.	STORY	SEQUENCE	TIME(SECs)	SCORE
1	PR 1			
2	PR 2			
3	SS 1			
4	MC 3			
5	FB 3			
6	FB 4			
7	MC 4			
8	SS 3			
9	MC 2			
10	FB1			
11	MC1			
12	SS 2			
13	FB 2			
14	SS 4			

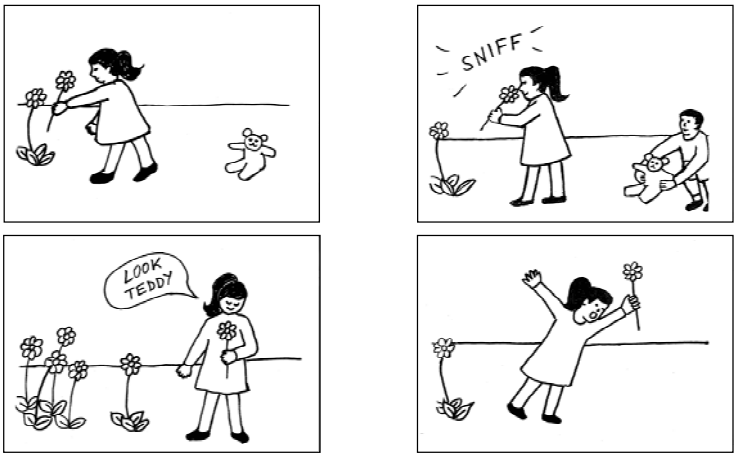
PR – Practice; SS- Social script; MC- Mechanical; FB- False belief.

UNEXPECTED CONTENTS THEORY OF MIND TASK:

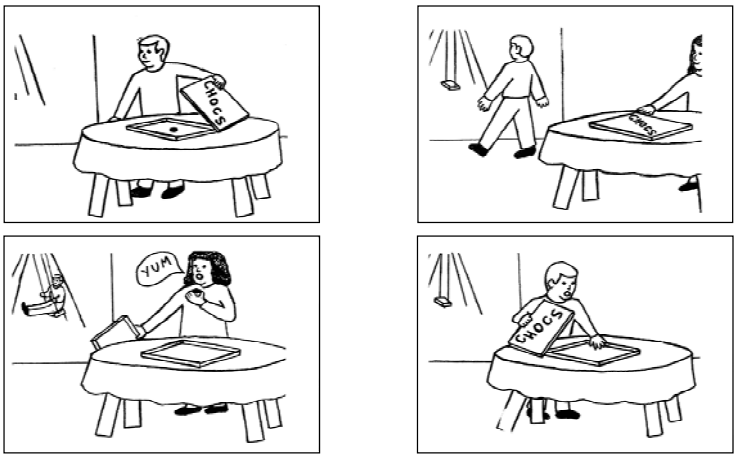
SERIAL NO.	QUESTION	ANSWER
1	REALITY	
2	APPEARANCE	
3	REPRESENTATIONAL CHANGE.	
4	FALSE BELIEF.	
	SCORE	

9.3. PICTURE SEQUENCING TASK

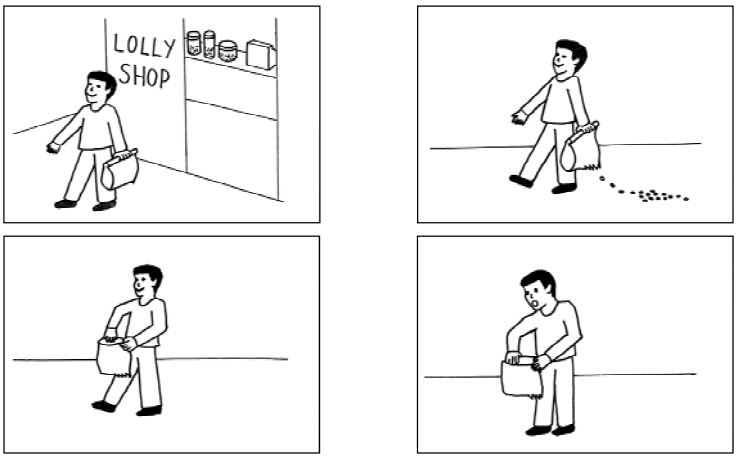
False belief 1



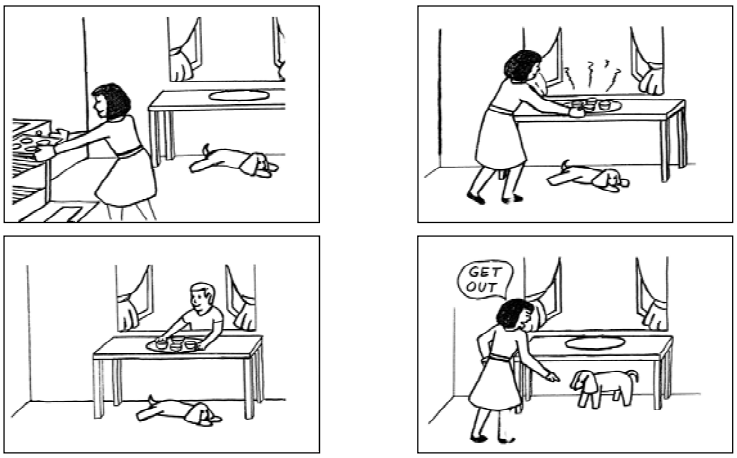
False belief 2



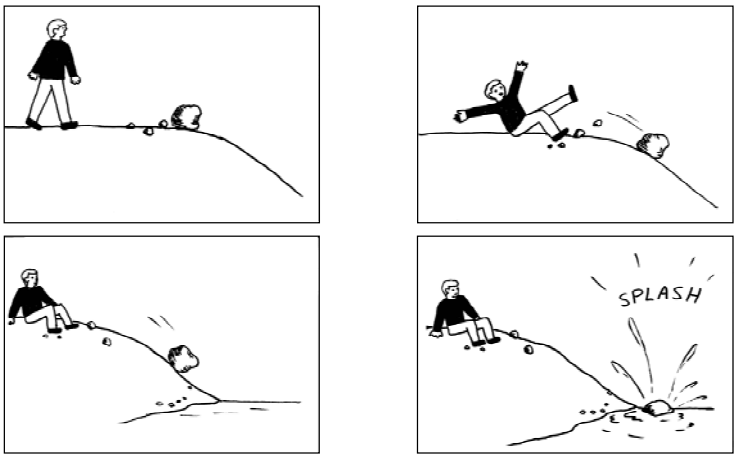
False belief 3



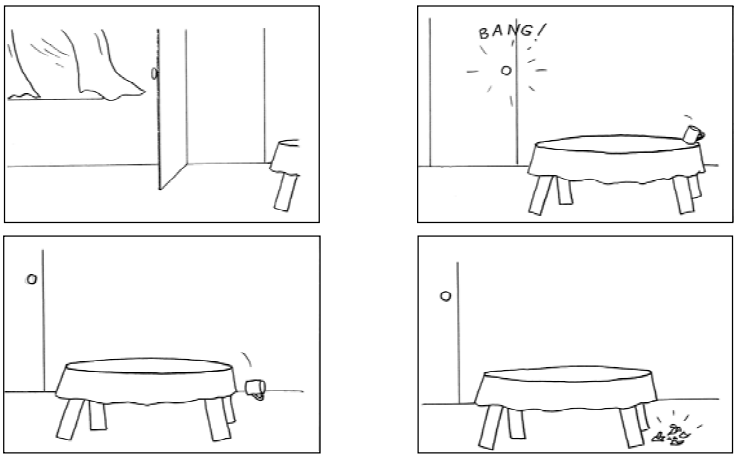
False belief 4



Mechanical 1



Mechanical 2



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9.4.1. STRENGTH AND DIFFICULTIES QUESTIONNAIRE (TAMIL).

9.4.2. STRENGTHS AND DIFFICULTY QUESTIONNAIRE KEY

□ SHAPE * MERGEFORMAT □□

Strengths and Difficulties QUESTIONNAIRE

RECORD SHEET

Name _____

Age _____ Male/Female

Strengths and Difficulties Questionaire completed by:

MAIN CARER ON _____

Teacher on _____

Self on _____

SCALE	LOW NEEDS	SOME NEEDS	HIGH NEEDS
CONDUCT PROBLEMS			
MAIN CARER	0–2	3	4–10
Teacher	0–2	3	4–10
Self	**0–3**	**4**	**5–10**
HYPERACTIVITY			
MAIN CARER	0–5	6	7–10
Teacher	0–5	6	7–10
Self	**0–5**	**6**	**7–10**
EMOTIONAL SYMPTOMS			
MAIN CARER	0–3	4	5–10
Teacher	0–4	5	6–10
Self	**0–5**	**6**	**7–10**
PEER PROBLEMS			
MAIN CARER	0–2	3	4–10
Teacher	0–3	4	5–10
Self	**0–3**	**4–5**	**6–10**
PRO-SOCIAL BEHAVIOUR			
MAIN CARER	6–10	5	0–4
Teacher	6–10	5	0–4
Self	**6–10**	**5**	**0–4**
TOTAL DIFFICULTIES			
MAIN CARER	0–13	14–16	17–40
Teacher	0–11	12–15	16–40
Self	**0–15**	**16–19**	**20–40**

Pro-social	0
Hyperactivity	0
Emotional	0
Pro-social	0
Conduct	0
Peer	0
Conduct	2
Emotional	0
Pro-social	0
Hyperactivity	0
Peer	2
Conduct	0
Emotional	0
Peer	2
Hyperactivity	0
Emotional	0
Pro-social	0
Conduct	0
Peer	0
Pro-social	0
Hyperactivity	2
Conduct	0
Peer	0
Emotional	0
Hyperactivity	2